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Concussion in Athletes: Information for Team Physicians on the Neurologic Evaluation

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The evaluation and management of concussion (ie, mild traumatic brain injury) in athletes is typically the responsibility of team or school physicians. The great majority of these physicians are orthopedists, family physicians, internists, pediatricians, or sports medicine specialists who have not had specialty training in neurology or neurosurgery. The evaluation and management of mild traumatic brain injury is primarily guided by a neurological clinical evaluation of the patient. The purpose of this article is to review relevant aspects of the neurological history and examination as well as the neurological approach to the concussed athlete.
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The clinical definition of concussion should be broad-based to err on the side of diagnostic caution in identifying concussion, which is also called mild traumatic brain injury (MTBI). It was not long ago when the diagnosis of concussion was primarily determined by a patient having sustained loss of consciousness (LOC). It is now generally accepted that, although LOC may or may not be present in concussion, its presence is not imperative for a diagnosis, and in fact is present in only a minority of sports-related MTBIs. The authors of a number of recent studies and consensus conferences have addressed concussion.[1-7]

We recommend use of the following definition for concussion.[8] Concussion is a complex pathophysiological process affecting the brain caused by traumatic biomechanical forces. It is manifested by:

- signs and symptoms commonly associated with postconcussion syndrome, including but not limited to headache, dizziness, nausea, fatigue, confusion, amnesia, photophobia, phonophobia, loss of balance, unsteadiness, syncope or near syncope, tinnitus, blurred vision, diplopia, loss of vision, drowsiness, lethargy, fatigue, disorientation to time, place and events and change in personality; and
- an alteration in awareness, memory, and/or consciousness.

Neurological Examination and Management of Concussion

The Initial On-Field Evaluation

The initial priority of the physician when evaluating an athlete who has sustained a head injury is to determine whether there is a need for immediate life-saving procedures, such as cardiopulmonary resuscitation, defibrillation, or intubation and to initiate any of such procedures that may be required. Concomitantly, the physician must be certain that the cervical spine has been appropriately immobilized until it is certain that there is no significant injury to that area. Once it has been determined that such interventions are not necessary, the next priority is to determine whether there is any suspicion of an acute neurosurgical emergency, such as intracranial hemorrhage (epidural, subdural, or parenchymal) or diffuse cerebral edema that would require emergent transport to a hospital for immediate brain imaging and neurosurgical consultation. The initial determination of the possibility of acute neurosurgical emergency is determined largely by the physician's immediate observations and examination of the injured athlete.

Observed LOC lasting longer than 1 minute,[9] vomiting, persistent drowsiness or lethargy, or seizure activity, either

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focal (ie, jerky clonic movements of one limb, one side of the body or face, with or without accompanying LOC) or generalized (ie, LOC accompanied by tonic stiffening of the trunk and bilateral limbs with or without bilateral jerky clonic movements of the limbs or face) should raise suspicion of an acute neurosurgical emergency and prompt immediate ambulance transport to a hospital facility with emergency brain scanning (computed tomography or magnetic resonance imaging) and neurosurgical capabilities. Initial neurological examination findings of inability to answer questions or follow commands, decreased level of consciousness, a unilaterally dilated pupil, deviation of the eyes to one side, disconjugate eye movements, weakness of one side of the face, slurring of speech, or weakness of one side of the body should raise similar suspicions and prompt the same response. To make these observations and recognize these neurological signs, the physician must know in advance how to approach the concussed athlete in the initial minutes.

In the helmeted sport setting, an adequate neurological assessment requires that the helmet, face mask, and mouthguard be removed (obviously this should not be done in instances of suspicion of cervical spine injury until stability of the cervical spine has been assured). Unless the physician has actually witnessed the concussion or observed that the athlete is still unconscious when the physician begins the examination, it can often be very difficult to accurately determine if the athlete sustained LOC, and if so, the duration of the LOC. The physician usually depends on the patient's report of whether there was LOC, which adds a significant amount of subjectivity to making a determination of whether the player had LOC for longer than 1 minute. However, the observant physician who calmly observes the injured athlete for a few moments can usually easily ascertain whether there is seizure activity or vomiting.

If the athlete is upright (sitting or standing) under their own volition and speaking, the physician should proceed to the more thorough neurological examination that is discussed later in this article. If, by contrast, the athlete remains lying on the playing surface or needs assistance to sit or stand or is not speaking, the physician should pursue a focused examination to quickly determine whether immediate transportation to a hospital is warranted. The physician can often observe whether the athlete is drowsy or lethargic because the eyes will be closed, there will usually be no spontaneous speech, and the player will not respond appropriately to questions or commands. At other times, however, the physician will need to perform a more formal evaluation to make an accurate determination regarding drowsiness, lethargy or other alterations of level of consciousness. To make such a determination, the physician should first observe whether the eyes are open or closed and whether the player is speaking spontaneously.

The physician should then ask the player a simple question, such as "What is your name?" or "How do you feel?" to determine whether the athlete is responding appropriately to questions. The player can then be told to stick out their tongue or open or close their eyes to determine if they are responding appropriately to commands. If there is no response to questions or commands, the physician should apply mildly noxious stimuli, such as pressing on a fingernail, or applying supraorbital pressure with one finger and observing if the player speaks, grimaces, pushes the examiner away, develops posturing of the limbs or does not respond at all. As noted previously, players with altered levels of consciousness at the time of initial physician evaluation should be treated as potential neurosurgical emergencies. If the patient speaks, the physician should listen carefully for evidence of slurring.

The physician should observe the size and symmetry of both pupils under ambient light and then shine a light at each pupil individually and observe if the appropriate pupillary constriction occurs in both eyes in response to the light stimulus. Asymmetry of the pupils (a difference in size of 2 mm or more) or failure of one or both pupils to constrict in response to the light stimulus could be signs of increased intracranial pressure with impending uncal herniation on the side of the larger pupil; therefore, such findings require immediate ambulance transport to a hospital equipped to deal with such emergencies. The physician should then observe the position of the eyes to determine whether there is conjugate deviation of both eyes to one side or if the eyes are in the midline. A spontaneous conjugate deviation or preponderance of eye position to 1 side is a sign of cerebral or brainstem/cerebellar dysfunction. An upward or downward deviation of the eyes indicates upper brainstem or thalamic dysfunction. Disconjugate eye movements are another sign of brainstem dysfunction. The presence of any of these eye movement abnormalities indicates the need for urgent brain imaging.

The physician should observe the injured player to determine whether the face is spontaneously symmetric and if there are symmetric spontaneous movements of all 4 extremities. If the player's limbs are not moving spontaneously, the physician should hold up and then let go of one arm and then the other as a means of detecting unilateral weakness. The presence of unilateral weakness of the face and/or limbs indicates the need for immediate transport to the hospital. At all times, the physician should maintain a high level of suspicion of a serious intracranial injury and a low threshold for sending an injured player to a hospital for urgent brain imaging.

The Sideline Evaluation

If the initial evaluation does not indicate the need for immediate transport to a hospital, the physician should then perform a more thorough sideline neurological evaluation. The purpose of this evaluation is 2-fold:

1. Observe for signs or symptoms that may suggest the development of a delayed life-threatening neurosurgical problem, such as epidural or subdural hematoma. These types of hemorrhages may not be obvious at the time of initial examination and may present with a worsening of the neurological status in the minutes or hours after the concussion. It is well known that a potentially fatal epidural hematoma can on occasion masquerade initially as a mild head injury; physicians should therefore maintain vigilance of their recently concussed patients.